

2.3 Drinking Water

Drinking water comes from surface water and ground water. Large-scale water supply systems tend to rely on surface water resources (including rivers, lakes, and reservoirs), while smaller water systems tend to use ground water. Slightly more than half of our nation's population receives its drinking water from ground water by means of wells drilled into aquifers (USGS, 1998).

To protect human health, EPA, under the Safe Drinking Water Act (SDWA), sets health-based standards (called maximum contaminant levels, or MCLs) for contaminants in drinking water. These standards specify the maximum allowable level of each regulated contaminant in drinking water. The standards also prescribe protocols, frequencies, and locations that water suppliers must use to monitor for about 90 regulated contaminants. The SDWA standards and associated monitoring and treatment by water suppliers provide a critical barrier that serves to protect the quality of much of our nation's drinking water. Some 55,000 community water systems in the U.S. test and treat water to remove contaminants before distributing it to customers.

This section addresses three questions relevant to evaluating progress in drinking water protection:

- What is the quality of drinking water?
- What are sources of drinking water contamination?
- What human health effects are associated with drinking contaminated water?

An indicator has been developed to help answer the first of these questions (Section 2.3.1). The second and third questions are addressed in Sections 2.3.2 and 2.3.3, respectively; however, no indicators were identified to answer these questions.

2.3.1 What is the quality of drinking water?

Indicators

Population served by community water systems that meet all health-based standards

In 2002, state data reported to EPA showed that approximately 251 million people were served by community water systems that had no violations of health-based standards. This number repre-

sents 94 percent of the total population served by community water systems, up from 79 percent in 1993. Under-reporting and late reporting of violations data by states to EPA affect the accuracy of this data.

The drinking water standards set by EPA under the Safe Drinking Water Act apply to public water systems (PWSs). PWSs are systems that serve at least 25 people or 15 service connections for at least 60 days a year. They may be publicly or privately owned. PWSs include:

- *Community water systems (CWSs)*—systems that supply water to the same population year-round. There are some 55,000 community water systems in the U.S.
- *Non-transient non-community water systems*—systems that regularly supply water to at least 25 of the same people at least 6 months per year, but not year-round (e.g., schools, factories, office buildings, and hospitals that have their own water systems).
- *Transient non-community water systems*—systems that provide water in a place where people do not remain for long periods of time (e.g., a gas station or campground).

Under the 1996 Amendments to the SDWA, EPA must go through several steps to determine, first, whether setting a standard is appropriate for a particular contaminant, and if so, what the standard should be. To make these determinations, EPA considers many factors for each contaminant, including:

- Its occurrence in the environment.
- Human exposure and the risks of adverse health effects in the general population and sensitive subpopulations.
- Analytical methods of detection.
- Available technology.
- How the regulation would impact water systems and public health.

As of 2003, about 90 contaminants are regulated in drinking water under the SDWA.

Indicator

Population served by community water systems that meet all health-based standards - Category I

Under SDWA regulations, all public water systems must monitor the quality of their drinking water and report the monitoring results to their state. Using these results, states determine whether a maximum contaminant level has been violated and must report all violations of federal drinking water regulations to EPA quarterly. The indicator presents the total population across the nation that is served by community water systems that met all health-based drinking water standards.

What the Data Show

In 2002, community water systems (CWS) served 268 million people—just over 95 percent of the U.S. population as recorded in the 2000 census. Analysis of state-reported violations data shows that, in 2002, 94 percent of this population was served by systems that met all drinking water standards (i.e., did not report violations of health-based standards) for the entire year (Exhibit 2-31).

Indicator Gaps and Limitations

Under-reporting and late reporting of CWS violations data by states to EPA affect the ability to accurately report the quality of our nation's drinking water. EPA last quantified the quality of violations data in 1999. Based on this analysis, the agency estimated that states were not reporting 40 percent of all health-based violations to EPA. EPA is continuing to verify state-reported CWS data and expects to issue an updated estimate of data quality in 2003.

Data Source

The underlying database for this indicator is EPA's Safe Drinking Water Information System/Federal version. (See Appendix B, page B-16 for more information.)

Exhibit 2-31: Population served by community water systems (CWSs) with no reported violations of health-based standards, 1993-2002

Fiscal Year	Population served by CWSs that had no reported violations	Percent of CWS-served population that was served by systems with no reported violations
2002	250,596,287	94
2001	239,927,650	91
2000	239,299,701	91
1999	229,805,285	91
1998	224,808,251	89
1997	215,351,842	87
1996	213,109,672	86
1995	208,700,100	84
1994	202,626,433	83
1993	196,229,162	79

Coverage: all 50 states

Source: EPA, Office of Water. *Safe Drinking Water Information Systems/Federal version (SDWIS/FED)*. 2003.

2.3.2 What are sources of drinking water contamination?

Microbiological, chemical, and radiological contaminants can enter water supplies. These contaminants may be produced by human activity or occur naturally. For instance, chemicals can migrate from disposal sites or underground storage systems and contaminate sources of drinking water. Animal wastes, pesticides, and fertilizers may be carried to lakes and streams by rainfall runoff or snow melt. Nitrates from fertilizers can also be carried by runoff and percolate through soil to contaminate ground water. Arsenic and radon are examples of naturally occurring contaminants that may be released into ground water as it travels through rock and soil.

Human wastes from sewage and septic systems or wastes from animal feedlots and wildlife carrying microbial pathogens may get into waters ultimately used for drinking. Coliform bacteria from human and animal wastes may be found in drinking water if the water is not properly treated or disinfected. These bacteria are used as indicators that other harmful microbial pathogens, such as *Giardia*, *Cryptosporidium*, and *E. coli* O157:H7, might be in the water.

Disinfection of drinking water is a critical public health measure as it provides a barrier against harmful microbes. Under the SDWA, all surface water supplies, and ground water supplies with close hydrological connections to surface water must disinfect (and most must also filter) their water to remove pathogens. However, disinfectants such as chlorine react with naturally occurring organic matter in source water and in distributions systems to form chemical by-products (known as disinfection by-products) such as trihalomethanes and haloacetic acid compounds.

For systems that disinfect, water leaves the plant with a disinfectant residual. However, in some cases water could become contaminated if there is a breach in the distribution system.

2.3.3 What human health effects are associated with drinking contaminated water?

Effects of exposure to contaminants in drinking water will vary depending on many factors, including the type of contaminant, its concentration in drinking water, and how much contaminated water is consumed over what period of time.

- **Chemical contaminants.** Chemical contaminants found or expected to occur in drinking water can include metals, pesticides, and solvents. Most of these would be expected to cause no health effects at the levels found in treated drinking water, but they may cause a variety of biological responses at high doses. These could include cosmetic effects (such as skin discoloration) or unpleasant odors, as well as more severe health effects such as nervous system or organ damage, developmental or reproductive effects, or cancer. One well-studied consequence of drinking contaminated water is the formation of methemoglobin in infants drinking formula with more than 10 ppm nitrate. This altered hemoglobin does not carry oxygen efficiently; too much of it in the blood of very young children can be fatal (i.e., blue baby syndrome).
- **Pathogens.** The consequences of consuming water with pathogenic microbes can include gastrointestinal illnesses causing stomach pain, diarrhea, headache, vomiting, and fever. Waterborne pathogens can cause diseases that are less common in the U.S., such as typhoid fever and cholera, as well as more common waterborne diseases such as giardiasis or cryptosporidiosis. Pathogenic microbes can enter water from human and animal wastes. One of the largest outbreaks of disease from contaminated water occurred in Milwaukee in 1993, when an estimated 400,000 people became ill from exposure to *Cryptosporidium*, a single-celled parasite that is found in the large intestines of a large number of animals, including cattle and humans. That outbreak killed more than 50 people, the vast majority of whom had seriously weakened immune systems (Hoxie, et al., 1997).

Drinking water disinfection is one of the great public health success stories of the 20th century. It has been a critical factor in reducing the incidence of waterborne diseases such as typhoid, cholera, and hepatitis, as well as gastrointestinal illness in the U.S. Though drinking water disinfection is a critical public health measure, the process does generate disinfection by-products, as mentioned earlier. These compounds have been associated with cancer, developmental, and reproductive risks, the extent of which is still uncertain (see Chapter 4—Human Health).